



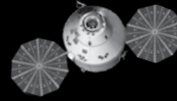
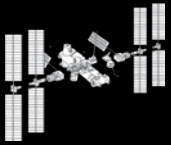
NASA Technologies Enhance Our Lives

Spinoff 2010 highlights recent significant research and development activities across the Agency and the successful transfer of NASA technologies to the marketplace. This brochure summarizes the commercial technologies profiled in *Spinoff* 2010; the full text is available for download at <http://spinoff.nasa.gov>, and print copies can be requested by calling (301) 286-0561 or through spinoff@sti.nasa.gov.



spinoff





Innovative technologies from NASA's space and aeronautics missions (above) transfer as benefits to many sectors of society. Each benefit featured in *Spinoff* 2010 is listed with an icon that corresponds to the mission from which the technology originated. The numbered bullets correspond to points on the centerfold map, illustrating the geographic distribution of the featured companies.



Health and Medicine

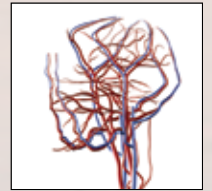
1 Burnishing Techniques Strengthen Hip Implants

In the late 1990s, Lambda Research Inc., of Cincinnati, Ohio, received Small Business Innovation Research (SBIR) awards from Glenn Research Center to demonstrate low plasticity burnishing (LPB) on metal engine components. By producing a thermally stable deep layer of compressive residual stress, LPB significantly strengthened turbine alloys. After Lambda patented the process, the Federal Aviation Administration accepted LPB for repair and alteration of commercial aircraft components, the U.S. Department of Energy found LPB suitable for treating nuclear waste containers at Yucca Mountain. Data from the U.S. Food and Drug Administration confirmed LPB to completely eliminate the occurrence of fretting fatigue failures in modular hip implants.



2 Signal Processing Methods Monitor Cranial Pressure

Dr. Norden Huang, of Goddard Space Flight Center, invented a set of algorithms (called the Hilbert-Huang Transform, or HHT) for analyzing nonlinear and nonstationary signals that developed into a user-friendly signal processing technology for analyzing time-varying processes. At an auction managed by Ocean Tomo Federal Services LLC, licenses of 10 U.S. patents and 1 domestic patent application related to HHT were sold to DynaDx Corporation, of Mountain View, California. DynaDx is now using the licensed NASA technology for medical diagnosis and prediction of brain blood flow-related problems, such as stroke, dementia, and traumatic brain injury.



3 Ultraviolet-Blocking Lenses Protect, Enhance Vision

To combat the harmful properties of light in space, as well as that of artificial radiation produced during laser and welding work, Jet Propulsion Laboratory (JPL) scientists developed a lens capable of absorbing, filtering, and scattering the dangerous light while not obstructing vision. SunTiger Inc.—now Eagle Eyes Optics, of Calabasas, California—was formed to market a full line of sunglasses based on the JPL discovery that promised 100-percent elimination of harmful wavelengths and enhanced visual clarity. The technology was recently inducted into the Space Technology Hall of Fame.



4 Hyperspectral Systems Increase Imaging Capabilities

In 1983, NASA started developing hyperspectral systems to image in the ultraviolet and infrared wavelengths. In 2001, the first on-orbit hyperspectral imager, Hyperion, was launched aboard the Earth Observing-1 spacecraft. Based on the hyperspectral imaging sensors used in Earth observation satellites, Stennis Space Center engineers and Institute for Technology Development researchers collaborated on a new design that was smaller and used an improved scanner. Featured in *Spinoff* 2007, the technology is now exclusively licensed by Themis Vision Systems LLC, of Richmond, Virginia, and is widely used in medical and life sciences, defense and security, forensics, and microscopy.





Transportation

5 Programs Model the Future of Air Traffic Management

Through Small Business Innovation Research (SBIR) contracts with Ames Research Center, Intelligent Automation Inc., based in Rockville, Maryland, advanced specialized software the company had begun developing with U.S. Department of Defense funding. The agent-based infrastructure now allows NASA's Airspace Concept Evaluation System to explore ways of improving the utilization of the National Airspace System (NAS), providing flexible modeling of every part of the NAS down to individual planes, airports, control centers, and even weather. The software has been licensed to a number of aerospace and robotics customers, and has even been used to model the behavior of crowds.



6 Tail Rotor Airfoils Stabilize Helicopters, Reduce Noise

Founded by former Ames Research Center engineer Jim Van Horn, Van Horn Aviation of Tempe, Arizona, built upon a Langley Research Center airfoil design to create a high performance aftermarket tail rotor for the popular Bell 206 helicopter. The highly durable rotor has a lifetime twice that of the original equipment manufacturer blade, reduces noise by 40 percent, and displays enhanced performance at high altitudes. These improvements benefit helicopter performance for law enforcement, military training, wildfire and pipeline patrols, and emergency medical services.



7 Personal Aircraft Point to the Future of Transportation

NASA's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, as well as a number of Agency innovations, have helped Duluth, Minnesota-based Cirrus Design Corporation become one of the world's leading manufacturers of general aviation aircraft. SBIRs with Langley Research Center provided the company with cost-effective composite airframe manufacturing methods, while crashworthiness testing at the Center increased the safety of its airplanes. Other NASA-derived technologies on Cirrus SR20 and SR22 aircraft include synthetic vision systems that help pilots navigate and full-plane parachutes that have saved the lives of more than 30 Cirrus pilots and passengers to date. Today, the SR22 is the world's top-selling Federal Aviation Administration (FAA)-certified single-engine airplane.



8 Ducted Fan Designs Lead to Potential New Vehicles

In 1994, aerospace engineers Rob Bulaga and Mike Moshier formed Trek Aerospace Inc., based in Folsom, California, to develop personal air vehicles using a novel ducted fan design. The company relied on Ames Research Center for a great deal of testing, the results of which have provided greater lift, lowered weight, more power, and improved maneuverability. The technology has been applied to three models: the Dragonfly UMR-1, the Springtail EFV, and the OVIWUN, a small-scale version that is for sale through the company's Web site. It is safer than a manned vehicle, and its size makes it relatively difficult for it to damage itself during test flights the way a larger mass, faster craft could.



9 Winglets Save Billions of Dollars in Fuel Costs

The upturned ends now featured on many airplane wings are saving airlines billions of dollars in fuel costs. Called winglets, the drag-reducing technology was advanced through the research of Langley Research Center engineer Richard Whitcomb and through flight tests conducted at Dryden Flight Research Center. Seattle-based Aviation Partners Boeing—a partnership between Aviation Partners Inc., of Seattle, and The Boeing Company, of Chicago—manufactures Blended Winglets, a unique design featured on Boeing aircraft around the world. These winglets have saved more than 2 billion gallons of jet fuel to date, representing a cost-savings of more than \$4 billion and a reduction of almost 21.5 million tons in carbon dioxide emissions.



10 Sensor Systems Collect Critical Aerodynamics Data

With the support of Small Business Innovation Research (SBIR) contracts with Dryden Flight Research Center, Tao of Systems Integration Inc. developed sensors and other components that will ultimately form a first-of-its-kind, closed-loop system for detecting, measuring, and controlling aerodynamic forces and moments in flight. The Hampton, Virginia-based company commercialized three of the four planned components, which provide sensing solutions for customers such as Boeing, General Electric, and BMW and are used for applications such as improving wind turbine operation and optimizing air flow from air conditioning systems. The completed system may one day enable flexible-wing aircraft with flight capabilities like those of birds.



11 Coatings Extend Life of Engines and Infrastructure

MesoCoat Inc., of Euclid, Ohio, collaborated with Glenn Research Center to provide thermal barrier coating (TBC) technology, developed by Glenn researcher Dongming Zhu, to enhance the lifespan and performance of engines in U.S. Air Force legacy aircraft. The TBC reduces thermal stresses on engine parts, increasing component life by 50 percent. MesoCoat is also producing metal cladding technology that may soon provide similar life-lengthening benefits for the Nation's infrastructure. Through a Space Act Agreement with Glenn, the company employs the Center's high-density infrared arc lamp system to bond its cladding materials for demonstration prototypes; the coating technology can prevent corrosion on metal beams, pipes, and rebar for up to 100 years.



Public Safety

12 Radiometers Optimize Local Weather Prediction

Radiometrics Corporation, headquartered in Boulder, Colorado, engaged in Small Business Innovation Research (SBIR) agreements with Glenn Research Center that resulted in a pencil-beam radiometer designed to detect supercooled liquid along flight paths—a prime indicator of dangerous icing conditions. The company has brought to market a modular radiometer that resulted from the SBIR work. Radiometrics' radiometers are used around the world as key tools for detecting icing conditions near airports and for the prediction of weather conditions like fog and convective storms, which are known to produce hail, strong winds, flash floods, and tornadoes. They are also employed for oceanographic research and soil moisture studies.





13 Energy-Efficient Systems Eliminate Icing Danger for UAVs

Ames Research Center engineer Leonard Haslim invented an anti-icing technology called an electroexpulsive separation system, which uses mechanical force to shatter potentially dangerous ice buildup on an aircraft surface. Temecula, California-based Ice Management Systems (now known as IMS-ESS) licensed the technology from Ames and has discovered a niche market for the lightweight, energy-efficient technology: unmanned aerial vehicles (UAVs). IMS-ESS systems now prevent damaging ice accumulation on military UAVs, allowing the vehicles to carry out crucial missions year round.



14 Rocket-Powered Parachutes Rescue Entire Planes

Small Business Innovation Research (SBIR) contracts with Langley Research Center helped BRS Aerospace, of Saint Paul, Minnesota, to develop technology that has saved 246 lives to date. The company's whole aircraft parachute systems deploy in less than 1 second thanks to solid rocket motors and are capable of arresting the descent of a small aircraft, lowering it safely to the ground. BRS has sold more than 30,000 systems worldwide, and the technology is now standard equipment on many of the world's top-selling aircraft. Parachutes for larger airplanes are in the works.



15 Technologies Advance UAVs for Science, Military

A Space Act Agreement with Goddard Space Flight Center and West Virginia University enabled Aurora Flight Sciences Corporation, of Manassas, Virginia, to develop cost-effective composite manufacturing capabilities and open a facility in West Virginia. The company now employs 160 workers at the plant, tasked with crafting airframe components for the Global Hawk unmanned aerial vehicle (UAV) program. While one third of the company's workforce focuses on Global Hawk production, the rest of the company develops advanced UAV technologies that are redefining traditional approaches to unmanned aviation. Since the company's founding, Aurora's cutting-edge work has been supported with funding from NASA's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.



16 Inflatable Antennas Support Emergency Communication

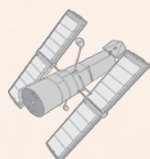
Glenn Research Center awarded Small Business Innovation Research (SBIR) contracts to ManTech SRS Technologies, of Newport Beach, California, to develop thin film inflatable antennas for space communication. With additional funding, SRS modified the concepts for ground-based inflatable antennas. GATR (Ground Antenna Transmit and Receive) Technologies, of Huntsville, Alabama, licensed the technology and refined it to become the world's first inflatable antenna certified by the Federal Communications Commission. Capable of providing Internet access, voice over Internet protocol, e-mail, video teleconferencing, broadcast television, and other high-bandwidth communications, the systems have provided communication during the wildfires in California, after Hurricane Katrina in Mississippi, and following the 2010 Haiti earthquake.





17 Smart Sensors Assess Structural Health

NASA frequently inspects launch vehicles, fuel tanks, and other components for structural damage. To perform quick evaluation and monitoring, the Agency pursues the development of structural health monitoring systems. In 2001, Acellent Technologies Inc., of Sunnyvale, California, received Small Business Innovation Research (SBIR) funding from Marshall Space Flight Center to develop a hybrid Stanford Multi-Actuator Receiver Transduction (SMART) Layer for aerospace vehicles and structures. As a result, Acellent expanded the technology's capability and now sells it to aerospace and automotive companies; construction, energy, and utility companies; and the defense, space, transportation, and energy industries for structural condition monitoring, damage detection, crack growth monitoring, and other applications.



18 Hand-Held Devices Detect Explosives and Chemical Agents

Ion Applications Inc., of West Palm Beach, Florida, partnered with Ames Research Center through Small Business Innovation Research (SBIR) agreements to develop a miniature version ion mobility spectrometer (IMS). While NASA was interested in the instrument for detecting chemicals during exploration of distant planets, moons, and comets, the company has incorporated the technology into a commercial hand-held IMS device for use by the military and other public safety organizations. Capable of detecting and identifying molecules with part-per-billion sensitivity, the technology now provides soldiers with portable explosives and chemical warfare agent detection. The device is also being adapted for detecting drugs and is employed in industrial processes such as semiconductor manufacturing.



19 Terahertz Tools Advance Imaging for Security, Industry

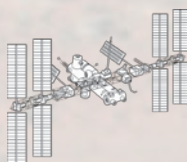
Picometrix, a wholly owned subsidiary of Advanced Photonix Inc. (API), of Ann Arbor, Michigan, invented the world's first commercial terahertz system. The company improved the portability and capabilities of their systems through Small Business Innovation Research (SBIR) agreements with Langley Research Center to provide terahertz imaging capabilities for inspecting the space shuttle external tanks and orbiters. Now API's systems make use of the unique imaging capacity of terahertz radiation on manufacturing floors, for thickness measurements of coatings, pharmaceutical tablet production, and even art conservation.

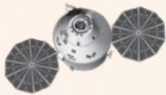


Consumer Goods

20 LED Systems Target Plant Growth

To help develop technologies for growing edible biomass (food crops) in space, Kennedy Space Center partnered with Orbital Technologies Corporation (ORBITEC), of Madison, Wisconsin, through the Small Business Innovation Research (SBIR) program. One result of this research was the High Efficiency Lighting with Integrated Adaptive Control (HELIAC) system, components of which have been incorporated into a variety of agricultural greenhouse and consumer aquarium lighting features. The new lighting systems can be adapted to a specific plant species during a specific growth stage, allowing maximum efficiency in light absorption by all available photosynthetic tissues.





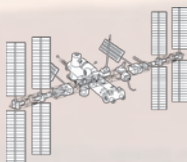
21 Aerogels Insulate Against Extreme Temperatures

In 1992, NASA started to pursue the development of aerogel for cryogenic insulation. Kennedy Space Center awarded Small Business Innovation Research (SBIR) contracts to Aspen Systems Inc., of Marlborough, Massachusetts, that resulted in a new manufacturing process and a new flexible, durable, easy-to-use form of aerogel. Aspen Systems formed Aspen Aerogels Inc., in Northborough, Massachusetts, to market the product, and by 2009, the company had become the leading provider of aerogel in the United States, producing nearly 20 million square feet per year. With an array of commercial applications, the NASA-derived aerogel has most recently been applied to protect and insulate people's hands and feet.



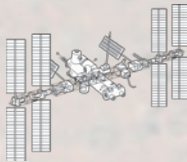
22 Image Sensors Enhance Camera Technologies

In the 1990s, a Jet Propulsion Laboratory team led by Eric Fossum researched ways of improving complementary metal-oxide semiconductor (CMOS) image sensors in order to miniaturize cameras on spacecraft while maintaining scientific image quality. Fossum's team founded a company to commercialize the resulting CMOS active pixel sensor. Now called the Aptina Imaging Corporation, based in San Jose, California, the company has shipped over 1 billion sensors for use in applications such as digital cameras, camera phones, Web cameras, and automotive cameras. Today, one of every three cell phone cameras on the planet feature Aptina's sensor technology.



23 Lightweight Material Patches Allow for Quick Repairs

Cornerstone Research Group Inc., of Dayton, Ohio, has been the recipient of 16 Small Business Innovation Research (SBIR) contracts with NASA with a variety of different focuses, including projects like creating inflatable structures for radio frequency antennas and, most recently, healable polymer matrix composites for future space vehicles. One of its earlier SBIR contracts, with Kennedy Space Center, led to the development of a new type of structural patch for a variety of consumer uses: Rubbn'Repair, for automotive uses; and Rec'Repair for the outdoors and adventure market. Both are flexible, heat-activated structural patches.



24 Nanomaterials Transform Hairstyling Tools

Dr. Dennis Morrison, a former scientist at Johnson Space Center, conducted research on microcapsules that were developed in space and designed to deliver drugs to cancerous tumors. This work led to research on nanoceramic materials, and in 2001, Morrison shared his expertise with Farouk Shami, the owner of Farouk Systems Inc., of Houston, Texas. After learning more, Shami developed a ceramic composite for his CHI (Cationic Hydration Interlink) hairstyling irons, brushes, nail lacquers, and hair dryers. Morrison also used his NASA research expertise as a platform to incorporate nanosilver and near-infrared light into the products.



25 Do-It-Yourself Additives Recharge Auto Air Conditioning

In planning for a return mission to the Moon, NASA aimed to improve the thermal control systems that keep astronauts comfortable and cool while inside a spacecraft. Goddard Space Flight Center awarded a Small Business Innovation Research (SBIR) contract to Mainstream Engineering Corporation, of Rockledge, Florida, to develop a chemical/mechanical heat pump. While working on the design, Mainstream Engineering came up with a unique liquid additive called QwikBoost to enhance the performance of the advanced heat pump design. IDQ Inc., of Garland, Texas, exclusively licensed the technology and incorporates it into its line of Arctic Freeze products for automotive air conditioning applications.

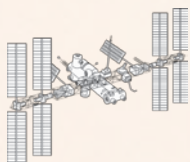




Environmental Resources

26 Systems Analyze Water Quality in Real Time

A water analyzer developed under Small Business Innovation Research (SBIR) contracts with Kennedy Space Center now monitors treatment processes at water and wastewater facilities around the world. Originally designed to provide real-time detection of nutrient levels in hydroponic solutions for growing plants in space, the ChemScan analyzer, produced by ASA Analytics Inc., of Waukesha, Wisconsin, utilizes spectrometry and chemometric algorithms to automatically analyze multiple parameters in the water treatment process with little need for maintenance, calibration, or operator intervention. The company has experienced a compound annual growth rate of 40 percent over its 15-year history as a direct result of the technology's success.



27 Compact Radiometers Expand Climate Knowledge

To gain a better understanding of Earth's water, energy, and carbon cycles, NASA plans to embark on the Soil Moisture Active and Passive mission in 2015. To prepare, Goddard Space Flight Center provided Small Business Innovation Research (SBIR) funding to ProSensing Inc., of Amherst, Massachusetts, to develop a compact ultrastable radiometer for sea surface salinity and soil moisture mapping. ProSensing incorporated small, low-cost, high-performance elements into just a few circuit boards and now offers two lightweight radiometers commercially. Government research agencies, university research groups, and large corporations around the world are using the devices for mapping soil moisture, ocean salinity, and wind speed.



28 Energy Servers Deliver Clean, Affordable Power

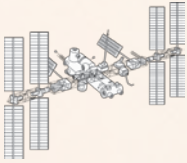
K.R. Sridhar developed a fuel cell device for Ames Research Center, that could use solar power to split water into oxygen for breathing and hydrogen for fuel on Mars. Sridhar saw the potential of the technology, when reversed, to create clean energy on Earth. He founded Bloom Energy, of Sunnyvale, California, to advance the technology. Today, the Bloom Energy Server is providing cost-effective, environmentally friendly energy to a host of companies such as eBay, Google, and The Coca-Cola Company. Bloom's NASA-derived Energy Servers generate energy that is about 67-percent cleaner than a typical coal-fired power plant when using fossil fuels and 100-percent cleaner with renewable fuels.



29 Solutions Remediate Contaminated Groundwater

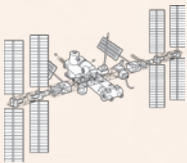
During the Apollo Program, NASA workers used chlorinated solvents to clean rocket engine components at launch sites. These solvents, known as dense non-aqueous phase liquids, had contaminated launch facilities to the point of near-irreparability. Dr. Jacqueline Quinn and Dr. Kathleen Brooks Loftin of Kennedy Space Center partnered with researchers from the University of Central Florida's chemistry and engineering programs to develop technology capable of remediating the area without great cost or further environmental damage. They called the new invention Emulsified Zero-Valent Iron (EZVI). The groundwater remediation compound is cleaning up polluted areas all around the world and is, to date, NASA's most-licensed technology.





30 Bacteria Provide Cleanup of Oil Spills, Wastewater

Through Small Business Innovation Research (SBIR) contracts with Marshall Space Flight Center, Micro-Bac International Inc., of Round Rock, Texas, developed a phototrophic cell for water purification in space. Inside the cell: millions of photosynthetic bacteria. Micro-Bac proceeded to commercialize the bacterial formulation it developed for the SBIR project. The formulation is now used for the remediation of wastewater systems and waste from livestock farms and food manufacturers. Strains of the SBIR-derived bacteria also feature in microbial solutions that treat environmentally damaging oil spills, such as that resulting from the catastrophic 2010 Deepwater Horizon oil rig explosion in the Gulf of Mexico.



31 Reflective Coatings Protect People and Animals

Led by Marshall Space Flight Center, NASA engineers called upon National Metalizing of Cranbury, New Jersey, to help create a reflective sunshield to deploy on Skylab in place of a shield that was lost during launch in 1973. Years later, a former employee for National Metalizing founded Advanced Flexible Materials (AFM) Inc., of Petaluma, California, and utilized the radiant barrier technology in the public domain to produce a variety of products such as wraps to keep marathon finishers safe from hypothermia as well as a lining for mittens and vests. Recently, the material helped to keep manatees warm as they were lifted from the water as part of a tag-and-release program.



Computer Technology

32 Innovative Techniques Simplify Vibration Analysis

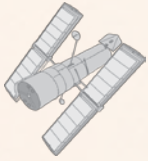
In the early years of development, Marshall Space Flight Center engineers encountered challenges related to components in the space shuttle main engine. To assess the problems, they evaluated the effects of vibration and oscillation. To enhance the method of vibration signal analysis, Marshall awarded Small Business Innovation Research (SBIR) contracts to AI Signal Research, Inc. (ASRI), in Huntsville, Alabama. ASRI developed a software package called PC-SIGNAL that NASA now employs on a daily basis, and in 2009, the PKP-Module won Marshall's "Software of the Year" award. The technology is also used in many industries: aircraft and helicopter, rocket engine manufacturing, transportation, and nuclear power.



33 Modeling Tools Predict Flow in Fluid Dynamics

Because rocket engines operate under extreme temperature and pressure, they present a unique challenge to designers who must test and simulate the technology. To this end, CRAFT Tech Inc., of Pipersville, Pennsylvania, won Small Business Innovation Research (SBIR) contracts from Marshall Space Flight Center to develop software to simulate cryogenic fluid flows and related phenomena. CRAFT Tech enhanced its CRUNCH CFD (computational fluid dynamics) software to simulate phenomena in various liquid propulsion components and systems. Today, both government and industry clients in the aerospace, utilities, and petrochemical industries use the software for analyzing existing systems as well as designing new ones.





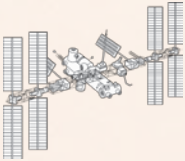
34 Verification Tools Secure Online Shopping, Banking

Just like rover or rocket technology sent into space, the software that controls these technologies must be extensively tested to ensure reliability and effectiveness. Ames Research Center invented the open-source Java Pathfinder (JPF) toolset for the deep testing of Java-based programs. Fujitsu Labs of America Inc., based in Sunnyvale, California, improved the capabilities of the JPF Symbolic Pathfinder tool, establishing the tool as a means of thoroughly testing the functionality and security of Web-based Java applications such as those used for Internet shopping and banking.



35 Toolsets Maintain Health of Complex Systems

First featured in *Spinoff* 2001, Qualtech Systems Inc. (QSI), of Wethersfield, Connecticut, adapted its Testability, Engineering, and Maintenance System (TEAMS) toolset under Small Business Innovation Research (SBIR) contracts from Ames Research Center to strengthen NASA's systems health management approach for its large, complex, and interconnected systems. Today, six NASA field centers utilize the TEAMS toolset, including TEAMS-Designer, TEAMS-RT, TEAMATE, and TEAMS-RDS. TEAMS is also being used on industrial systems that generate power, carry data, refine chemicals, perform medical functions, and produce semiconductor wafers. QSI finds TEAMS can lower costs by decreasing problems requiring service by 30 to 50 percent.



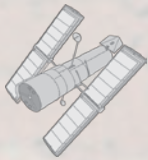
36 Framework Resources Multiply Computing Power

As an early proponent of grid computing, Ames Research Center awarded Small Business Innovation Research (SBIR) funding to 3DGeo Development Inc., of Santa Clara, California, (now FusionGeo Inc., of The Woodlands, Texas) to demonstrate a virtual computer environment that linked geographically dispersed computer systems over the Internet to help solve large computational problems. By adding to an existing product, FusionGeo enabled access to resources for calculation- or data-intensive applications whenever and wherever they were needed. Commercially available as Accelerated Imaging and Modeling, the product is used by oil companies and seismic service companies, which require large processing and data storage capacities.



37 Tools Automate Spacecraft Testing, Operation

NASA began the Small Explorer (SMEX) program to develop spacecraft to advance astrophysics and space physics. As one of the entities supporting software development at Goddard Space Flight Center, the Hammers Company Inc. (tHC Inc.), of Greenbelt, Maryland, developed the Integrated Test and Operations System to support SMEX. Later, the company received additional Small Business Innovation Research (SBIR) funding from Goddard for a tool to facilitate the development of flight software called VirtualSat. NASA uses the tools to support 15 satellites, and the aerospace industry is using them to develop science instruments, spacecraft computer systems, and navigation and control software.





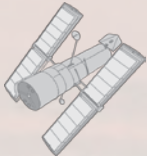
38 GPS Software Packages Deliver Positioning Solutions

To determine a spacecraft's position, the Jet Propulsion Laboratory (JPL) developed an innovative software program called the GPS (global positioning system)-Inferred Positioning System and Orbit Analysis Simulation Software, abbreviated as GIPSY-OASIS, and also developed Real-Time GIPSY (RTG) for certain time-critical applications. First featured in *Spinoff* 1999, JPL has released hundreds of licenses for GIPSY and RTG, including to Longmont, Colorado-based DigitalGlobe. Using the technology, DigitalGlobe produces satellite imagery with highly precise latitude and longitude coordinates and then supplies it for uses within defense and intelligence, civil agencies, mapping and analysis, environmental monitoring, oil and gas exploration, infrastructure management, Internet portals, and navigation technology.



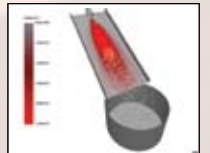
39 Solid-State Recorders Enhance Scientific Data Collection

Under Small Business Innovation Research (SBIR) contracts with Goddard Space Flight Center, SEAKR Engineering Inc., of Centennial, Colorado, crafted a solid-state recorder (SSR) to replace the tape recorder onboard a Spartan satellite carrying NASA's Inflatable Antenna Experiment. Work for that mission and others has helped SEAKR become the world leader in SSR technology for spacecraft. The company has delivered more than 100 systems, more than 85 of which have launched onboard NASA, military, and commercial spacecraft—including imaging satellites that provide much of the high-resolution imagery for online mapping services like Google Earth.



40 Computer Models Simulate Fine Particle Dispersion

Through a NASA Seed Fund partnership with DEM Solutions Inc., of Lebanon, New Hampshire, scientists at Kennedy Space Center refined existing software to study the electrostatic phenomena of granular and bulk materials as they apply to planetary surfaces. The software, EDEM, allows users to import particles and obtain accurate representations of their shapes for modeling purposes, such as simulating bulk solids behavior, and was enhanced to be able to more accurately model fine, abrasive, cohesive particles. These new EDEM capabilities can be applied in many industries unrelated to space exploration and have been adopted by several prominent U.S. companies, including John Deere, Pfizer, and Procter & Gamble.



Industrial Productivity



41 Composite Sandwich Technologies Lighten Components

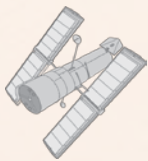
Leveraging its private resources with several Small Business Innovation Research (SBIR) contracts with both NASA and the U.S. Department of Defense, WebCore Technologies LLC, of Miamisburg, Ohio, developed a fiber-reinforced foam sandwich panel it calls TYCOR that can be used for a wide variety of industrial and consumer applications. Testing at Glenn Research Center's Ballistic Impact Facility demonstrated that the technology was able to exhibit excellent damage localization and stiffness during impact. The patented and trademarked material has found use in many demanding applications, including marine, ground transportation, mobile shelters, bridges, and most notably, wind turbines.





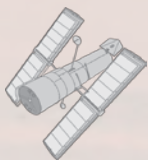
42 Cameras Reveal Elements in the Short Wave Infrared

Goodrich ISR Systems Inc. (formerly Sensors Unlimited Inc.), based out of Princeton, New Jersey, received Small Business Innovation Research (SBIR) contracts from the Jet Propulsion Laboratory, Marshall Space Flight Center, Kennedy Space Center, Goddard Space Flight Center, Ames Research Center, Stennis Space Center, and Langley Research Center to assist in advancing and refining indium gallium arsenide imaging technology. Used on the Lunar Crater Observation and Sensing Satellite (LCROSS) mission in 2009 for imaging the short wave infrared wavelengths, the technology has dozens of applications in military, security and surveillance, machine vision, medical, spectroscopy, semiconductor inspection, instrumentation, thermography, and telecommunications.



43 Deformable Mirrors Correct Optical Distortions

By combining the high sensitivity of space telescopes with revolutionary imaging technologies consisting primarily of adaptive optics, the Terrestrial Planet Finder is slated to have imaging power 100 times greater than the Hubble Space Telescope. To this end, Boston Micromachines Corporation, of Cambridge, Massachusetts, received Small Business Innovation Research (SBIR) contracts from the Jet Propulsion Laboratory for space-based adaptive optical technology. The work resulted in a microelectromechanical systems (MEMS) deformable mirror (DM) called the Kilo-DM. The company now offers a full line of MEMS DMs, which are being used in observatories across the world, in laser communication, and microscopy.



44 Stitching Techniques Advance Optics Manufacturing

Because NASA depends on the fabrication and testing of large, high-quality aspheric (non-spherical) optics for applications like the James Webb Space Telescope, it sought an improved method for measuring large aspheres. Through Small Business Innovation Research (SBIR) awards from Goddard Space Flight Center, QED Technologies, of Rochester, New York, upgraded and enhanced its stitching technology for aspheres. QED developed the SSI-A, which earned the company an "R&D 100" award, and also developed a breakthrough machine tool called the aspheric stitching interferometer. The equipment is applied to advanced optics in telescopes, microscopes, cameras, medical scopes, binoculars, and photolithography.



45 Compact, Robust Chips Integrate Optical Functions

Located in Bozeman, Montana, AdvR Inc. has been an active partner in NASA's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. Langley Research Center engineers partnered with AdvR through the SBIR program to develop new, compact, lightweight electro-optic components for remote sensing systems. While the primary customer for this technology will be NASA, AdvR foresees additional uses for its NASA-derived circuit chip in the fields of academic and industrial research—anywhere that compact, low-cost, stabilized single-frequency lasers are needed.



46 Fuel Cell Stations Automate Processes, Catalyst Testing

Glenn Research Center looks for ways to improve fuel cells, which are an important source of power for space missions, as well as the equipment used to test fuel cells. With Small Business Innovation Research (SBIR) awards from Glenn, Lynntech Inc., of College Station, Texas, addressed a major limitation of fuel cell testing equipment. Five years later, the company obtained a patent and provided the equipment to the commercial world. Now offered through TesSol Inc., of Battle Ground, Washington, the technology is used for fuel cell work, catalyst testing, sensor testing, gas blending, and other applications. It can be found at universities, national laboratories, and businesses around the world.



47 Onboard Systems Record Unique Videos of Space Missions

Ecliptic Enterprises Corporation, headquartered in Pasadena, California, provided onboard video systems for rocket and space shuttle launches before it was tasked by Ames Research Center to craft the Data Handling Unit that would control sensor instruments onboard the Lunar Crater Observation and Sensing Satellite (LCROSS) spacecraft. The technological capabilities the company acquired on this project, as well as those gained developing a high-speed video system for monitoring the parachute deployments for the Orion Pad Abort Test Program at Dryden Flight Research Center, have enabled the company to offer high-speed and high-definition video for geosynchronous satellites and commercial space missions, providing remarkable footage that both informs engineers and inspires the imagination of the general public.



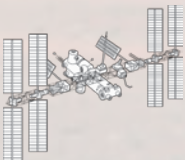
48 Space Research Results Purify Semiconductor Materials

One of NASA's Commercial Space Centers, the Space Vacuum Epitaxy Center (SVEC), had a mission to create thin film semiconductor materials and devices through the use of vacuum growth technologies. In partnership with Johnson Space Center, researchers spent years in the lab where they advanced a technique called molecular beam epitaxy. In 1997, researchers from the SVEC formed a company called Applied Optoelectronics Inc., of Sugar Land, Texas, to fabricate devices using the advanced techniques and knowledge. Today, the company develops and manufactures optical devices for fiber optic networks including cable television, wireless, telecommunications, data communications, and fiber-to-the-home applications.



49 Toolkits Control Motion of Complex Robotics

Control and simulation software developed under Small Business Innovation Research (SBIR) contracts with Johnson Space Center is now providing user-friendly, optimized design and control of innovative robots used for military, agriculture, health care, and industrial applications. Created by Energid Technologies Corporation, of Cambridge, Massachusetts, the Actin toolkit provides for fluid robot motion, enhancing strength and accuracy while avoiding collisions and joint limits. Actin provides control capabilities for virtually any kind of robot, any joint type or tool type, and for any number of joints, degrees of freedom, and branches. In addition, the software provides powerful simulation capabilities, allowing developers to rapidly devise and test robot designs before the robot is built.





Health and Medicine

- 1 Burnishing Techniques Strengthen Hip Implants (OH)
- 2 Signal Processing Methods Monitor Cranial Pressure (CA)
- 3 Ultraviolet-Blocking Lenses Protect, Enhance Vision (CA)
- 4 Hyperspectral Systems Increase Imaging Capabilities (VA)



Transportation

- 5 Programs Model the Future of Air Traffic Management (MD)
- 6 Tail Rotor Airfoils Stabilize Helicopters, Reduce Noise (AZ)
- 7 Personal Aircraft Point to the Future of Transportation (MN)
- 8 Ducted Fan Designs Lead to Potential New Vehicles (CA)
- 9 Winglets Save Billions of Dollars in Fuel Costs (WA)
- 10 Sensor Systems Collect Critical Aerodynamics Data (VA)
- 11 Coatings Extend Life of Engines and Infrastructure (OH)



Public Safety

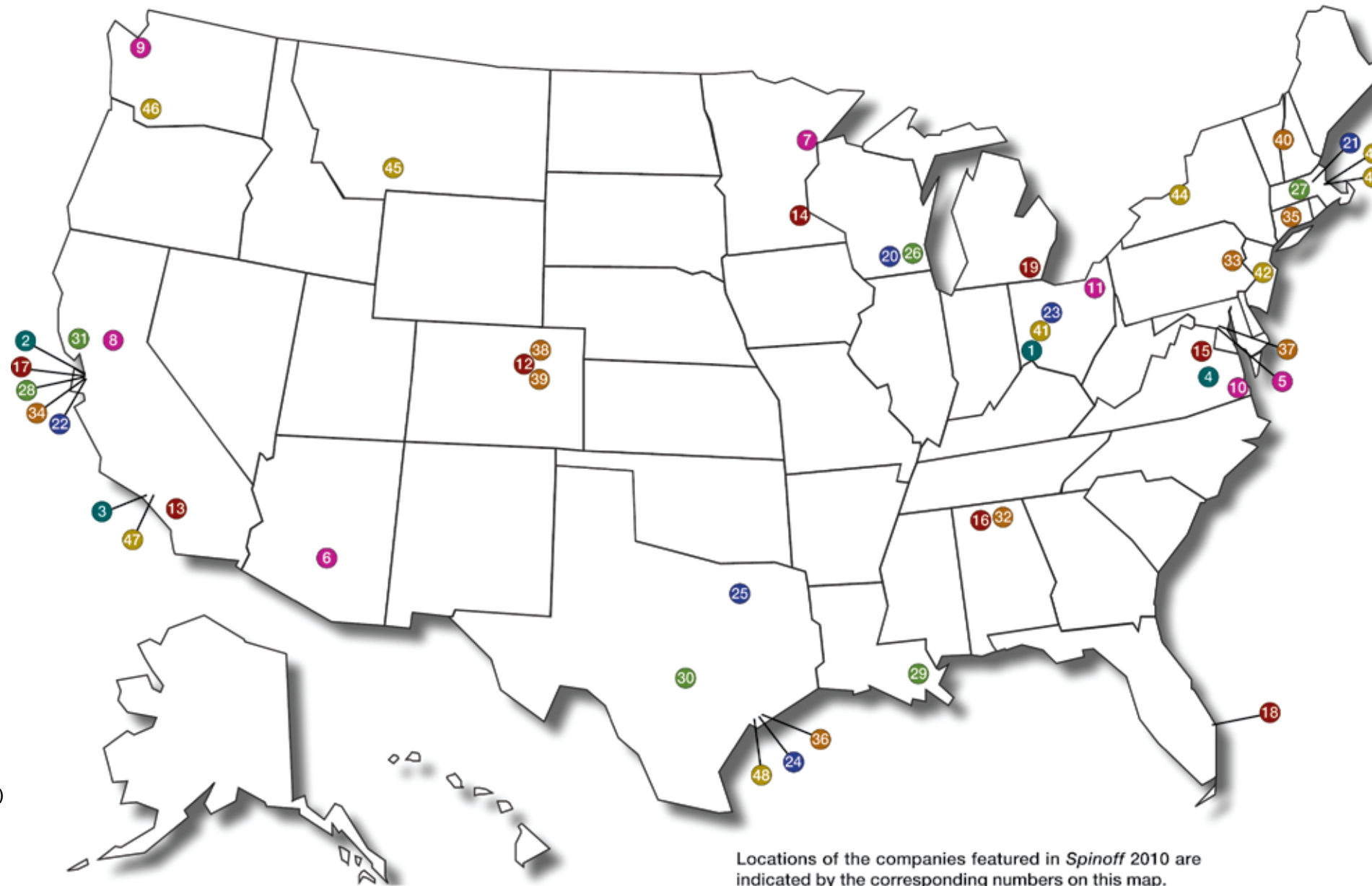
- 12 Radiometers Optimize Local Weather Prediction (CO)
- 13 Energy-Efficient Systems Eliminate Icing Danger for UAVs (CA)
- 14 Rocket-Powered Parachutes Rescue Entire Planes (MN)
- 15 Technologies Advance UAVs for Science, Military (VA)
- 16 Inflatable Antennas Support Emergency Communication (AL)
- 17 Smart Sensors Assess Structural Health (CA)
- 18 Hand-Held Devices Detect Explosives and Chemical Agents (FL)
- 19 Terahertz Tools Advance Imaging for Security, Industry (MI)



Consumer Goods

- 20 LED Systems Target Plant Growth (WI)
- 21 Aerogels Insulate Against Extreme Temperatures (MA)
- 22 Image Sensors Enhance Camera Technologies (CA)
- 23 Lightweight Material Patches Allow for Quick Repairs (OH)
- 24 Nanomaterials Transform Hairstyling Tools (TX)
- 25 Do-It-Yourself Additives Recharge Auto Air Conditioning (TX)

NASA Technologies Benefiting Society



Environmental Resources

- 26 Systems Analyze Water Quality in Real Time (WI)
- 27 Compact Radiometers Expand Climate Knowledge (MA)
- 28 Energy Servers Deliver Clean, Affordable Power (CA)
- 29 Solutions Remediate Contaminated Groundwater (LA)
- 30 Bacteria Provide Cleanup of Oil Spills, Wastewater (TX)
- 31 Reflective Coatings Protect People and Animals (CA)



Computer Technology

- 32 Innovative Techniques Simplify Vibration Analysis (AL)
- 33 Modeling Tools Predict Flow in Fluid Dynamics (PA)
- 34 Verification Tools Secure Online Shopping, Banking (CA)
- 35 Toolsets Maintain Health of Complex Systems (CT)
- 36 Framework Resources Multiply Computing Power (TX)
- 37 Tools Automate Spacecraft Testing, Operation (MD)
- 38 GPS Software Packages Deliver Positioning Solutions (CO)
- 39 Solid-State Recorders Enhance Scientific Data Collection (CO)
- 40 Computer Models Simulate Fine Particle Dispersion (NH)



Industrial Productivity

- 41 Composite Sandwich Technologies Lighten Components (OH)
- 42 Cameras Reveal Elements in the Short Wave Infrared (NJ)
- 43 Deformable Mirrors Correct Optical Distortions (MA)
- 44 Stitching Techniques Advance Optics Manufacturing (NY)
- 45 Compact, Robust Chips Integrate Optical Functions (MT)
- 46 Fuel Cell Stations Automate Processes, Catalyst Testing (WA)
- 47 Onboard Systems Record Unique Videos of Space Missions (CA)
- 48 Space Research Results Purify Semiconductor Materials (TX)
- 49 Toolkits Control Motion of Complex Robotics (MA)

The Nation's investment in NASA's aerospace research has brought practical benefits back to Earth in the form of commercial products and services in the fields of health and medicine; transportation; public safety; consumer goods; environmental resources; computer technology; and industrial productivity. *Spinoff*, NASA's premier annual publication, features these commercialized technologies. Since its inception in 1976, *Spinoff* has profiled NASA-derived products from companies across the Nation. An online archive of all stories from the first issue of *Spinoff* to the latest is available in an online database at www.sti.nasa.gov/spinoff/database.

Visit the Office of the Chief Technologist at <http://www.nasa.gov/oct>.

Office of the Chief Technologist

Building upon the successes of NASA's former Innovative Partnerships Program (IPP), The Office of the Chief Technologist (OCT) facilitates the transfer of new technologies to the private sector. It is also the organization within NASA responsible for providing cutting edge research, technology, and innovation to enable the Agency's grand missions in aeronautics, science, and exploration while advancing our Nation's technological future. With offices at each of NASA's 10 field centers, OCT represents an important aspect of our overall national investment in research, technology, and innovation, designed to stimulate our economy, create new inventions and capabilities, and increase our global economic competitiveness. In FY 2010:

- NASA entered into over 300 Space Act Agreements with private and other external entities for development of dual-use technology targeted to Mission Directorate technology needs.
- The former IPP facilitated the signing of about 290 license agreements and 575 Software Use Agreements. IPP facilitated the reporting of more than 1400 new invention disclosures. As a result of IPP's efforts, over 80 NASA patent applications were filed and about 80 patents awarded in FY 2010. Revenues realized from licenses of NASA-sponsored technologies exceeded \$3.5 million in FY 2010.
- IPP funded commercial parabolic flight services for 17 projects involving external entities that can take advantage of limited exposure to reduced gravity to mature NASA mission-relevant technologies.
- IPP provided \$2 million in funding for 41 Innovation Fund projects to encourage creation of breakthrough technologies by NASA civil servant inventors. IPP funding was matched by \$800,000 in external contributions in those cases where the projects involved partnering.
- NASA completed six Centennial Challenge events during the past year and awarded \$3.65 million in combined prize money to eight winning teams at four competitions. All of the winners participated in a technical symposium and recognition ceremony at NASA Headquarters in February. Preparations are underway for the 2011 Power Beaming and Green Flight Challenges as well as three new challenges announced this year: Nano-Satellite Launch, Night Rover and Sample Return Robot.
- Numerous NASA-derived technologies continued to yield direct public benefits in addition to their intended NASA applications, including 49 of the top recent examples that are highlighted in this 2010 edition of *Spinoff*.

OCT: Cutting edge research, technology, and innovation to advance our Nation's future.



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National Aeronautics and Space Administration

NASA Headquarters
300 E Street SW
Washington, DC 20546

www.nasa.gov

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